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GRAPHICAL USER INTERFACE (GUI) FOR THE WARFIGHTER PHYSIOLOGICAL STATUS MONITORING (WPSM) SYSTEM – U.S. ARMY MEDIC RECOMMENDATIONS

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The Warfighter Physiological Status Monitoring (WPSM) system collects vital sign information and other event information. This information is sent wirelessly to a personal digital assistant (PDA) held by the medic. The primary purpose of this study was to determine what features should be included in the graphical user interface (GUI) of the WPSM system as it would appear on the Battfield Medical Information Sytstem-Tactical (BMIS-T) PDA. To meet this objective, infomation was obtained from 26 experienced combat medics. A background questionnaire was administered to obtain information regarding the volunteers' medical experience, types of injuries and illnesses observed or treated, and how medical decisions such as triage assessments are made during combat. Secondly, these volunteers were asked to design individual GUI screens after being provided a briefing on what the WPSM system is. Finally, four focus groups of between 4 and 7 medics provided group consensus feedback on what the GUIs for the WPSM system should look like. Results from the volunteers' individual GUI designs and focus group sessions revealed most medics wanted a 1) geo-location screen, 2) a screen summarizing the medical status of the squad or platoon they were monitoring, 3) an individual patient screen, 4) a treatment and evacuation information screen, 5) an electronic Field Medical Card (FMC), and 6) a reference information screen. Certain summary information obtained from individual Warfighters should be able to be linked to higher levels of command and control personnel. Medical information about treatments and the record of vital sign information obtained from the wounded Warfighter should travel to the location of the next higher level of care that Warfighter will receive. In summary, these medics embraced the idea of the WPSM system being a tool that allowed them to do their job more efficiently and effectively. However, they felt the technology should serve as a supplement rather than a replacement for trained combat experienced medics. This study documents what combat-experienced medics consider to be important medical information and how they would like it to be displayed.

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Human subjects participated in these studies after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRMC Regulation 70-25 on the use of volunteers in research.

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BACKGROUND

The Warfighter Physiological Status Monitoring (WPSM) system is a physiological monitoring system designed to reduce the likelihood of non-battle environmental related injury and to help the medic during combat provide better care to the Warfighters he or she is responsible for. The system aids the medic by providing him or her with timely vital sign and other information such as geo-location. In conjunction with this WPSM system worn by future Warfighters, the medic will have a personal digital assistant (PDA) equipped with the Battlefield Medical Information System – Tactical (BMIS-T). The BMIS-T was designed to provide medical record keeping and enable an automatic medical inventory re-supply system. The BMIS-T has been developed and is in limited use at the present time. It is envisioned that the WPSM system could make use of the BMIS-T by having the BMIS-T serve as the platform that receives information gathered and transmitted by WPSM sensors. A number of engineers and software designers have developed prototype graphical user interface (GUI) designs for the WPSM system that can run on a PDA as part of the BMIS-T software program. The preferences of expert medical personnel have been taken into account in designing these prototype GUIs. However, to date no direct feedback has been obtained from experienced medics and others from the user community. This study addresses that need by having combat experienced medics provide direct feedback both individually via a paper and pencil exercise and also through small focus groups (4 to 7 individuals) where group consensus was sought on the value of the various prototype GUI screens. In briefings to medics, the WPSM system was presented in the context of a tool to help in a combat casualty care environment. These results will help WPSM GUI developers design a display that meets the needs of the end-user.

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EXECUTIVE SUMMARY

The Warfighter Physiological Status Monitoring (WPSM) system collects vital sign information and other event information such as whether a Soldier is 1) walking, standing, or lying down, 2) drinking an adequate amount of fluids, or 3) has been hit by a bullet or some other projectile. This information is sent wirelessly to a personal digital assistant (PDA) held by the medic. A special PDA equipped with the Battlefield Medical Information System - Tactical (BMIS-T) has already been developed and is being used by some medics for inventory control of supplies and medical record keeping. It is envisioned that the WPSM system would use the BMIS-T as the platform for displaying the information the medic needs to assess the status of the Warfighters he or she is monitoring. **Objective:** The primary purpose of this study was to determine what features should be included in the graphical user interface (GUI) of the WPSM system as it would appear on the BMIS-T PDA. To meet this objective, experienced combat medics were queried to obtain this end-user information. **Methods:** Information was obtained from 26 combat medics located at Ft. Sam Houston, TX and Aberdeen Proving Ground, MD. A background questionnaire was administered to obtain information regarding the volunteers' medical experience, types of injuries and illnesses observed or treated, and how medical decisions such as triage assessments are made during combat. Secondly, these volunteers were asked to design individual GUI screens after being provided a briefing on what the WPSM system is, what information it can provide to the medic, and a display of three prototype designs developed by engineers at USARIEM (Natick, MA), the Telemedicine and Advanced Technology Research Center (TATRC) (Ft. Detrick, MD), and Dartmouth College (Hanover, NH). Finally, four focus groups of between 4 and 7 medics provided group consensus feedback on what the GUIs for the WPSM system should look like. **Results:** Twenty-five of the medics had combat experience with most serving at least one tour in the on-going wars in Iraq and Afghanistan. Most (68%) were line medics, i.e., medics assigned to and traveling with dismounted Warfighter units. Results from the volunteers' individual GUI designs and focus group sessions revealed most medics wanted a 1) geo-location screen, 2) a screen summarizing the medical status of the squad or platoon they were monitoring, 3) an individual patient screen, 4) a treatment and evacuation information screen, 5) an electronic Field Medical Card (FMC), and 6) a reference information screen. Certain summary information obtained from individual Warfighters should be able to be linked to higher levels of command and control personnel. For example, squad or platoon strength could be summarized and sent to a unit's commander. Medical evacuation information when entered by the medic into his PDA should go to the appropriate medical evacuation unit that will be responsible for removing the casualty from the battlefield. Finally, medical information about treatments and the record of vital sign information obtained from the wounded Warfighter should travel to the location of the next higher level of care that Warfighter will receive. **Conclusion:** In summary, these medics embraced the idea of the WPSM system being a tool that allowed them to do their job more efficiently and effectively. However, they felt the technology should serve as a supplement rather than a replacement for trained combat experienced medics. This study documents what combat-experienced medics consider to be important medical information and how they would like it to be displayed.

INTRODUCTION

Vital sign information obtained from the Warfighter Physiological Status Monitoring (WPSM) system will be sent wirelessly from the Warfighters on the battlefield to the medic who may be positioned some distance away. Allowing detailed medical information to be transferred to the medic should improve the speed and efficacy of treatment rendered to fallen Warfighters. The medic is likely to view this vital sign information on a personal digital assistant (PDA) equipped with the Battlefield Medical Information System – Tactical (BMIS-T) software. The BMIS-T is a medical software tool that can be run on a number of different computer systems. For the medic in the field it is run on a PDA. The BMIS-T was developed as a way of medical record keeping in the field and also to provide the field medic with a handheld repository of clinical information and medical references (Fleming-Michael, 2003, Morris et al., 2003). A Soldier's medical information can be stored on a small personal information carrier (PIC) card, sometimes referred to as an electronic dog tag. This PIC card when inserted into the BMIS-T PDA allows the medic to access medical history information from that Soldier and to enter current information regarding diagnosis and treatment information of new injuries or illnesses. The BMIS-T also allows a medic or commander to take a snapshot look of their troops to ascertain overall troop health strength from a medical standpoint (Fleming-Michael, 2003). The BMIS-T is currently in use by troops in Afghanistan and Iraq and has been used with the White House staff, and last year was sent to medical personnel treating victims of Hurricane Katrina (Thormeyer, 2005).

The WPSM system is composed of a vital sign detection system (VSDS) which assess heart rate, respiration rate, skin temperature, body position, and body motion. A ballistic impact detection system (BIDS), fluid intake monitor, sleep watch, temperature pill or skin temperature patch and a hub are also components of the system. The hub serves as the personal area network where sensor information is gathered from the various sensors. In addition, WPSM algorithms to monitor life sign state, thermal state, hydration state and cognitive state are housed on the hub. Life sign state assesses live-dead status, thermal state assesses heat strain to the individual, hydration state assesses whether an individual in under- or over-hydrated (Hoyt and Friedl), while cognitive state assesses one’s cognitive capability based on past sleep history determined through actigraphy from the wrist-worn sleep watch (Hursh et al., 2004).

The various components of the system are at varying Technical Readiness Levels (TRLs). For, example a VSDS from Hidalgo (Hidalgo, Ltd; Swavesey, Cambridge, UK) is at a relatively high TRL level as it recently (November 2006) received Food and Drug Administration 510k certification while the BIDS is currently at a much lower TRL level. However, during this study no distinction between TRLs were made in the presentation of what the future WPSM system as currently configured would be capable of doing. There also has been some development of prototype graphical user interfaces (GUIs) for the WPSM system, some published (Hoyt and Friedl, 2004), and some not published, e.g., GUIs developed by Dartmouth College (Hanover, NH) and the Telemedicine and Advanced Technology Research Center (TATRC), Ft. Detrick, MD.

The BMIS-T GUI used to accesses medical records, medical reference material, clinical guidelines functions, and re-supply of drugs and other medical supplies are well established. However, what information to display and how to best display WPSM information is not yet defined. The purpose of this study was to obtain feedback from combat medics, the intended user group, of how the WPSM system GUI should look and function to best meet the needs of medics operating in combat environments.

METHODS

Twenty-six U.S. Army combat medic test volunteers were recruited at Ft. Sam Houston in San Antonio, TX (*n* = 13) and at Aberdeen Proving Ground; Aberdeen, MD (*n* = 13). Present duty stations included Aberdeen Proving Ground (*n* = 12), Ft. Sam Houston (*n* = 9), Ft. Drum, NY (*n* = 2), Ft. Polk, LA (*n* = 1), Ft. Hood, TX (*n* = 1), and Ft. Meade, MD (*n* = 1). Prior to data collection, all volunteers were briefed on the purpose and procedures and informed of their right to not participate if they so desired. The study was approved by USARIEM's Institute's Scientific Review and Human Use Research Committees. No personal identifiers of any type were used during data collection.

MEDIC - BACKGROUND MEDICAL EXPERIENCE

A background questionnaire assessing medics' experience both in training and combat was given. This questionnaire may be viewed in Appendix 1. Clinical information provided in response to open-ended questions was reviewed by a physician who had been deployed as a practicing physician in the Iraq War in 2003.

INDIVIDUAL GRAPHICAL USER INTERFACE (GUI) DESIGNS

Volunteers were shown three different conceptual GUI designs showing how data obtained from the WPSM system could be displayed on the medic's BMIS-T PDA. These conceptual designs came from USARIEM (Natick, MA) (Appendix 2), a Dartmouth College developed system from the Automated Remote Triage and Emergency Management Information System (ARTEMIS) (Appendix 3), and from TATRC (Appendix 4). Volunteers were also provided with 3 X 5 inch notebooks and asked to design GUI screens they thought would be optimum for their use. The size of the notebook pages were approximately the size of a PDA screen, hence volunteers were told to take into account how much information they would want on an individual screen. Volunteers were provided with various color pens so that various icons and or screen items could be color-coded. Volunteers were instructed that each page of the notebook should represent a screen on the PDA. Volunteers were also instructed to orientate their notebook to either portrait or landscape in their GUI designs to designate the orientation they would want the information to be displayed on their PDA.

The following constraints were imposed on this exercise.

1. Only the graphics technology present on one of the three GUI systems (USARIEM, Dartmouth, or TATRC) should be used. For example, camera phone technology where you can see an actual patient would not be available.

2. A color coding system to signify injury or illness status was to be used where red = attention needed immediately, yellow = attention should be given, green = no attention needed, Warfighter good to go, and blue = don't know, for example a sensor lead might have come off or the sensor itself is not functioning.

3. The GUIs designed should be usable in field training and combat situations.

4. Only the following vital sign information should be incorporated:
    a. Heart rate
    b. Respiration rate
    c. Body position
    d. Body motion
    e. Skin temperature/Core temperature
    f. Amount of sleep

5. Only the following context and event information should be incorporated:
    a. Geo-location (azimuth/distance; grid location on map)
    b. Time, timer, clock
    c. Ballistic Impact Detection System (BIDS) i.e., a projectile registered hit
    d. 911 button activated
    e. Fluid consumption recorded by a fluid intake monitor
    f. Evacuation status
    g. Record of patient interaction – the Field Medical Card (FMC) (DD Form 1380)

6. Only the following states (algorithms developed as described briefly on Page 2 of this report) information should be incorporated:
    a. Life signs
    b. Thermal
    c. Hydration
    d. Cognitive

FOCUS GROUPS

Focus group sessions were set up to allow medics to exchange ideas with one another and share those with this study's researchers who served as moderators for the groups. Focus groups were neither videotaped nor audio recorded. Drawings of focus group ideas for GUI display screens were made on poster boards as they were presented and agreed upon by the group. Two focus groups of 6 and 7 individuals were set up at both the Ft. Sam Houston and Aberdeen Proving Ground data collection sites

for a total of 4 groups. Focus groups with 4 to 7 participants are consistent with standard practice (Fern, 1982). The moderators had no financial or professional stake in the evaluation outcome of this product. The moderators followed the guidelines recommended by Aaker and Day (1986) such as not using jargon, making sure all volunteers contributed their ideas, not allowing one participant to dominate, and validating each idea as important. Topics introduced proceeded from general to more specific and followed the general outline by McQuarrie and McIntyre (1986). The following general topics were discussed:

- How many screens are desired?
- How should a user navigate between screens (tool bar, web-based like design, icon, etc.)?
- How will the 911 alert button when activated be represented?
- How will time be tracked?
- How will location of troops be represented?
- How will changes in various measures be represented?
- How will treatment status be represented?
- Should it be possible to enter information, and if so how?

Four prototype GUI displays were generated, one for each group from the focus group sessions. Each display reflected the consensus of all members of that particular focus group.

DATA ANALYSIS

Survey data and tabulation of various characteristics present on the individual GUI designs were tabulated and analyzed using SPSS 14.0 statistical software (SPSS, Inc., Chicago, IL). Frequency of responses and descriptive statistics were obtained.

RESULTS

BACKGROUND MEDICAL INFORMATION SURVEY

Detailed background information on the medical and combat experiences is summarized in Appendix E.

INDIVIDUAL GRAPHICAL USER INTERFACE (GUI) SCREEN DESIGNS

Tabulating the results from medics' individual GUI screen designs showed that

- 69.2% of medics had some form of home screen

- 11.5% of medics had a home button on each screen to allow them to immediately get back to the home screen

- 61.5% of medics wanted the screen orientation to be viewed as portrait

- 26.9% preferred landscape views

- 11.5% of medics thought that both portrait and landscape should be utilized depending on the individual screen information

- The average number of different screens the medic would scroll through for the specific information he or she wanted was 4.1± 2.0 screens with a minimum of 2 and a maximum of 7 screens

- 38.5% of the medics had a navigation bar. However, those that did not have a navigation bar did not explain how one would navigate through to the different screens

- One medic stated there should be an emergency delete button, while another medic had a lock-unlock function to be able to view the information. The medic who wanted the emergency delete button stated he would use it to delete all relevant information about his unit and mission if captured by the enemy

- 15.4% of medics had an enemy alert of some kind, either on the map displayed as a "hot zone" in red or dashed red lines overlaying the map (n = 3) or an enemy alert button (n = 1). It was unclear if the enemy alert button was something that alerted the medic or something the medic could push to let others know he/she was in the presence of the enemy

- 88.5% of medics had some form of geo-location information built into the display (Table 1) with the presence of a map (map or map with grid coordinates) cited 53.9% of the time. Of the fourteen medics who wanted a map, nine preferred a topographical type, four a satellite map, and one medic wanted the option to toggle between a topographical and satellite-grid map. Four medics wanted the map to have a zoom-in/out function.

Table 1. Geo-location information

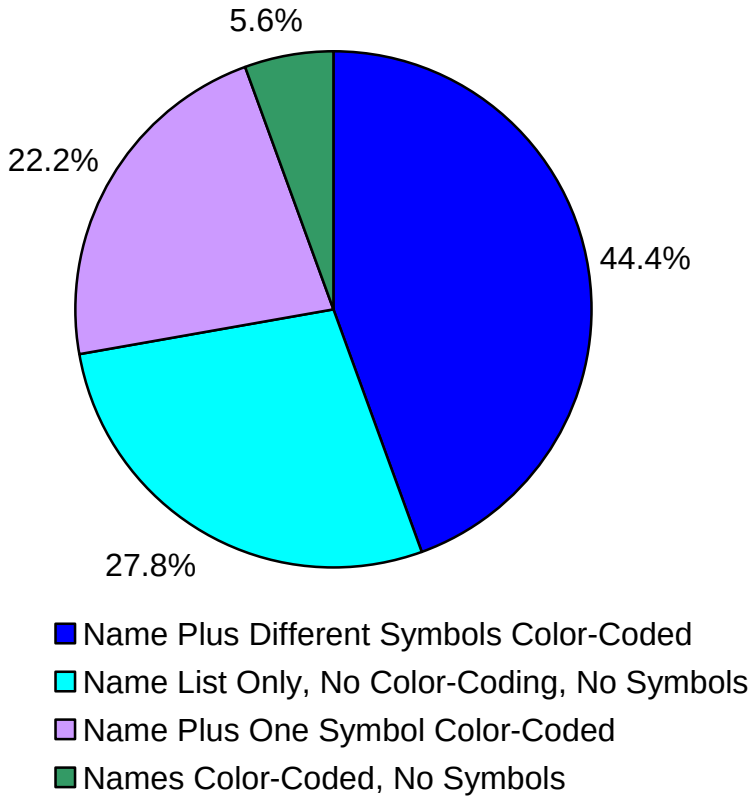
Had This Feature	*n*	% of Total
Geo-location information of some kind (e.g., map, grid coordinates, etc.)	23	88.5
Map with grid coordinates	10	38.5
Distance to patient	9	34.6
Azimuth	6	23.1
Grid coordinates only	8	30.8
Map only	4	15.4
Platoon location	4	15.4
Ground elevation	2	7.7
Ambient temperature	2	7.7
Battalion Aid Station or Combat Support Hospital location displayed	1	3.8
Time to patient	1	3.8

With regard to troop representation on the graph:

- 12 of 26 medics (46.2%) wanted troop location presented in a graphical form on the map.
- 10 of 26 medics (38.5%) wanted injured soldiers displayed in a different color and symbol.
- One medic wanted injured soldiers to be displayed with a blinking icon.
- Another medic wanted a combination of colored symbols with a blinking icon.
- 3 of 26 medics (11.5%) mentioned that they would want a time update of troop location associated with the map screen.
- 5 of 26 medics (19.2%) stated they would like time displayed. Of these, four wanted local time displayed and one wanted both local and Zulu time displayed.
- Two medics wanted a timer clock that began for each patient when they were designated as injured.
- 5 of 12 medics (19.2%) wanted the date listed on the map or their home screen.
- One medic wanted to have battery level of the PDA displayed.

The majority of medics 18 of 26 (69.2%) had a name-list screen. Figure 1 summarizes the different representations the name-list screen could have. Of those with a name-list screen, 6 of 18 (33%) had some form of geo-location associated with the name. Of those with a name-list, 8 of 18 (44.4%) wanted some vital medical information presented next to the name.

Figure 1. Name-list characteristics of those who had a name-list
(*n* = 18 or 69% of total volunteers)



Five of 26 medics (19.2%) thought summary information should be linked to information provided to higher levels of medical care (e.g., Combat Support Hospital) or to tactical personnel (e.g., command staff or a Fire Direction Center). A summary of information presented on the name-list screen is shown in Table 2.

Eight of 26 medics (30.8%) specified that clicking on the name of the patient on the name-list screen should bring them to a detailed individual patient screen. Most medics, 22 of 26 (84.6%), had a detailed individual patient screen. Twenty-three of 26 medics (88.5%) had on one of their screens an overall color-coded status of the Warfighters they were monitoring.

The information provided by the WPSM algorithms regarding thermal, hydration, and cognitive states of Warfighters were used by a minority of medics (Table 3), in part because the WPSM system was presented as a tool medics could use to treat casualties on the battlefield during combat. The use of the WPSM algorithms would certainly be more important in **preventing** injury or illness during training or combat.

Table 2. Name-list screen information

Had This Feature	*n*	% of Total
Physiological variables color-coded (red, yellow, green, blue)	11	42.3
Social Security Number	9	34.6
Geo-location information	6	23.1
Unit name of Soldier listed	4	15.4
List of allergies	2	7.7
Vehicle number of Soldier listed	1	3.8
Mechanism of injury obtained	1	3.8
Prior medical history	1	3.8
Gender	1	3.8
Military tracking or roster number	1	3.8
Medical Information		
Respiration rate	8	30.8
Pulse	6	23.1
Pulse oxiemtry (SPO_2)	4	15.4
Heart rate	4	15.4
Core or skin temperature	4	15.4
Hydration status	2	7.7
Blood pressure	2	7.7
Sleep status	1	3.8

Table 3. Use of WPSM algorithms status

Had This Feature	*n*	% of Total
Hydration status	9	34.6
Thermal status	6	23.1
Life-sign status	6	23.1
Sleep/cognitive status	2	7.7

Table 4 summarizes the information present on the individual patient screens. This summary shows that medics wanted the individual vital sign information presented.

- Of those medics who had an individual patient screen, 19 of 22 (86.4%) had a patient diagram with a color code of the injured area
- One medic had multiple patients with diagrams on one screen
- Two medics wanted to use a combination of yellow and red codes to designate the severity of injured areas, while the remaining 17 medics used only a red code to designate an injured area
- One medic that did not have a patient diagram wanted a color code listing of injured areas by listing the body part with a color code associated with it depending on whether it was injured or not

Table 4. Detailed individual medical patient screen information

Had This Feature	*n*	% of Total
Individual patient diagram	19	73.1
Color-coded injured area	19	73,1
Name of patient	17	65.4
911 Button activated alert	12	46.2
Ballistic Impact Detection System (BIDS) alert	9	34.6
Prior medical history	9	34.6
List of allergies	6	23.1
Age of patient	5	19.2
Physiological variables color-coded (red, yellow, green, blue)	5	19.2
Current medications of patient	5	19.2
Field Medical Card or Tag card (place where medic enters information)	4	15.4
Way of viewing front and back of patient diagram (toggle button or 2 views)	4	15.4
Mechanism of injury obtained	1	3.8
Time since 911 button was activated	1	3.8
Gender	1	3.8
Military tracking or roster number	1	3.8
Medical Information		
Respiration rate (RR)	17	65.4
Core or skin temperature (T_c or T_{sk})	15	57.7
Pulse	11	42.3
Heart rate (HR)	11	42.3
Blood pressure (BP)	9	34.6
RR history (use of arrow to signify if RR is going up or down)	8	30.5
HR history (use of arrow to signify if HR is going up or down)	6	23.1
Pulse oxiemtry (SPO_2)	4	15.4
Blood loss information	4	15.4
T_c history (use of arrow to signify if T_c is going up or down)	4	15.4
Body position	3	11.5
SPO_2 history (use of arrow to signify if SPO_2 is going up or down)	3	11.5
Graph of ~ last 10 min of HR	3	11.5
Pulse rate history (use of arrow to signify if pulse is going up or down)	3	11.5
T_c history (graph of ~ last 10 min of T_c)	2	7.7
RR history (graph of ~ last 10 Min of RR)	2	7.7
BP history (graph of ~ last 10 Min of BP)	2	7.7
Body motion	2	7.7
Blood type	2	7.7
Store ECG record info beginning at time of injury	1	3.8
Pulse rate history (graph of ~ last 10 min of pulse rate)	1	3.8
Alert/pain status	1	3.8
Airway status	1	3.8
Breath status	1	3.8

Approximately a third of the medics, 9 of 26 (34.6%), had an electronic FMC screen to input data, while an additional 6 medics had a place to input data as part of the detailed patient medical screen. The type of information to be recorded by medics is listed in Table 5. A place to input evacuation status was most important, cited by 14 of 26 medics (53.8%). Medics wanted the ability to record the treatment provided including diagnoses of illnesses and injuries after a medical exam was conducted. They also wanted to be able to override the life sign status of the system (3 of 26 medics, 11.5%). For example, if after treating a Warfighter, the Warfighter was able to return to the battlefield his life sign status could be changed by the medic from red or yellow back to green. The use of a black code was used by 11.5% of medics to signify a dead Warfighter. Another 11.5% indicated that the medic could designate a dead Warfighter with a black code but the system shouldn't do it automatically. About a third (8 of 26 medics, 30.8%) specifically indicated that a black code should not be used at all. These medics said the red or blue codes depending on the physiological information they were receiving should be used. For the other 12 of 26 (46.2%) medics it was unknown whether they would use a black code or not to signify a dead Soldier. Use of a blue code to signify unknown status was used by 6 of 26 (23.1%) medics.

Table 5. Medical information recorded

Had This Feature	*n*	% of Total
Evacuation Status	14	53.8
Air evacuation status	3	11.5
Ground evacuation status	3	11.5
Evacuation priority status	3	11.5
Treatment Provided	8	30.8
IV administered	4	15.4
Splints administered	2	7.7
Cervical collar administered	1	3.8
Tourniquet administered	2	7.7
J-Tube administered	2	7.7
Blood pressure taken	2	7.7
Bandages administered	1	3.8
Advanced life support needed	1	3.8
Medical supply list	3	11.5
Schematic of person to document treatment	1	3.8
Mechanism of injury recorded	1	3.8

FOCUS GROUPS

A composite of most often cited ideas from the four focus groups or unique ideas generated by one focus group were incorporated into one set of 7 screens (Figures 2a to 2g) that medics in this study felt should be part of a WPSM GUI design.

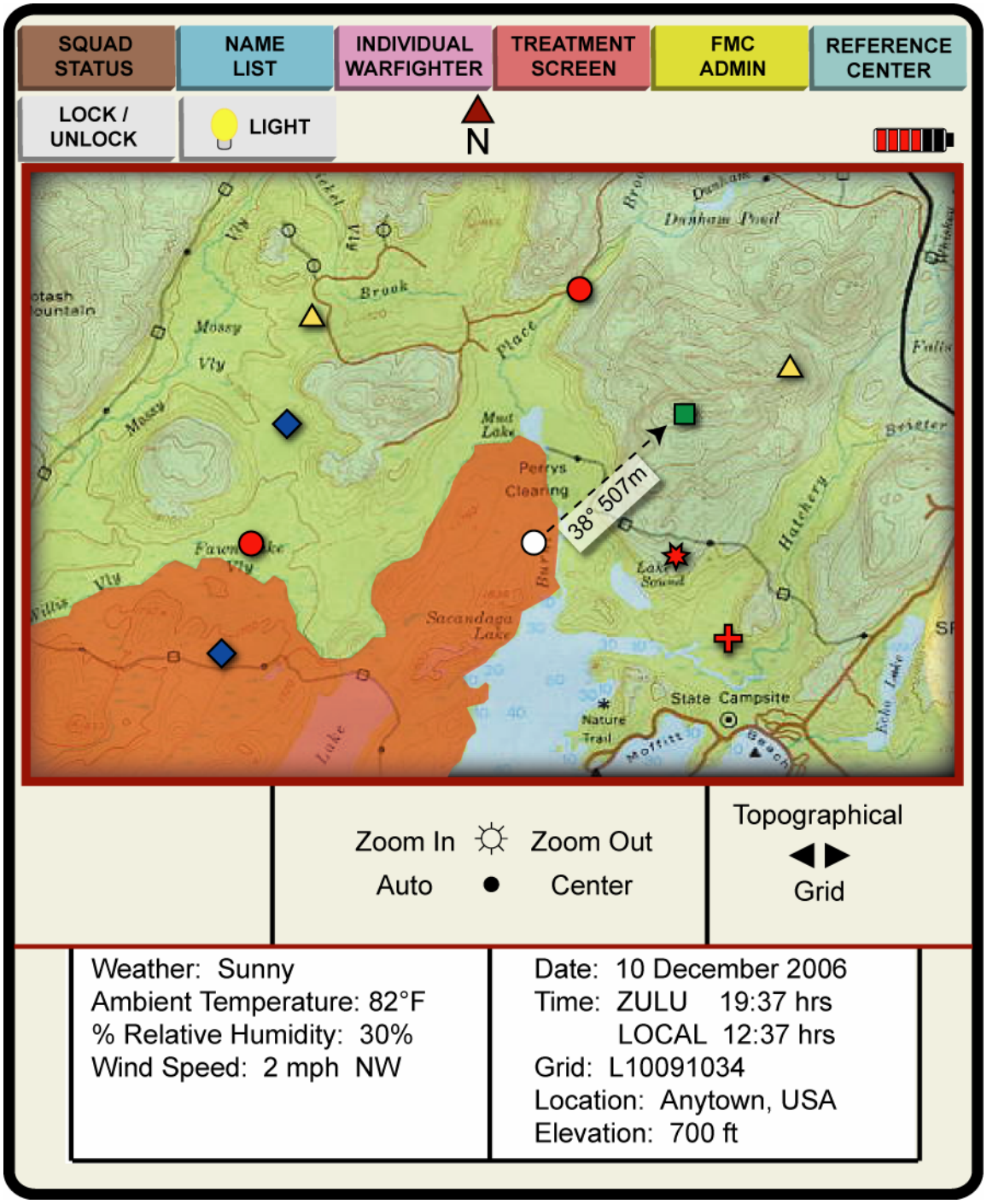
A general characteristic for all screens would be navigation buttons at the top to move to another screen. In addition there would be a button that locked the display

screens. A password would have to be used to unlock the displays if the lock button had been pushed. When in the lock state tapping on the lock/unlock would provide the prompt to type in a password. Tapping on the Individual Warfighter or Treatment Screen buttons would have the medic prompted to enter what Warfighter they were interested in. Tapping on the light button would illuminate the screen to make it brighter so that it could be read in the dark. Battery strength of the PDA would also be represented. Medics recommended that their PDA vibrate or make an auditory alert (mode could be set by the medic much as pagers work) so that if they had the device in their pocket they would be alerted to a change in the status of the Warfighters they were monitoring. Medics also mentioned they would like the information shown on their PDA to be linked to an eyes-down display so that they can be looking at the information while in route to their casualty without always having to look at their PDA. Others suggested they could wear it on their forearm with a protective cover so they wouldn't have to hold it while treating a patient or doing other things with their hands.

Other things for future development that these medics suggested were for the BMIS-T PDA to be able to take pictures. They said this would be extremely helpful for documentation and also if telemedicine type advice could be given by more senior medics or medical doctors stationed away from the field at the Battalion Aid Station or the Combat Support Hospital. They also wanted the BMIS-T to aid them in getting supplies. They expressed the need to have quicker re-supply and this could be accomplished through automated inventorying. Medics were told the BMIS-T already provides this function. In response, they stated they thought the BMIS-T was a great tool but that it needs to be supplied to all medics. The groups interviewed in this study had no experience with the BMIS-T.

The following figures are the proposed graphical user interface (GUI) screens developed from 4 focus groups of U.S. Army medics. A description of each screen follows the screen either on the next page or below the screen.

Figure 2a. Screen 1: Map location of individual Warfighters by platoon or squad

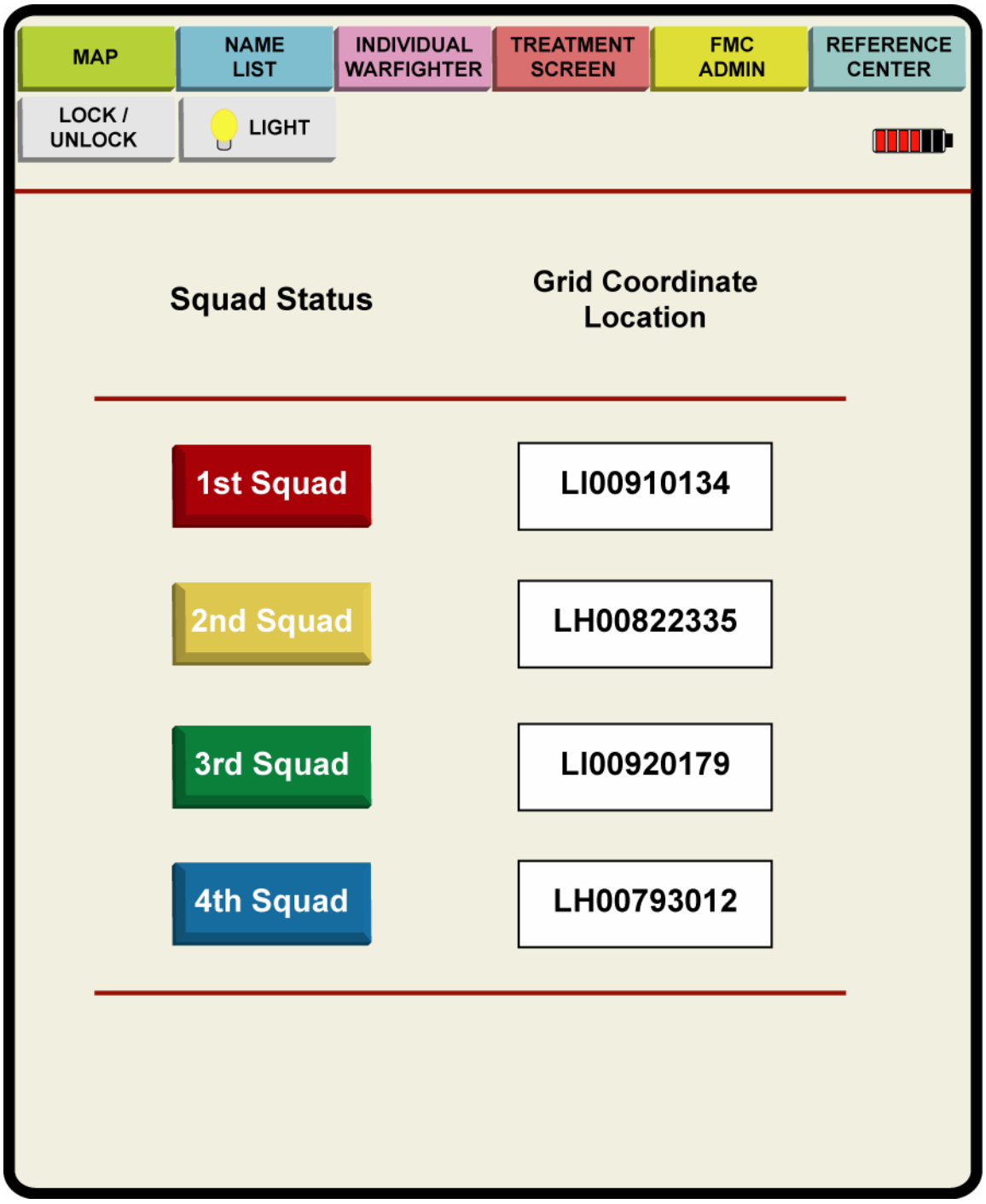


Screen 1 – Map Location of Individual Warfighters by Platoon or Squad

The first screen (Figure 2a) would start with a general map with location position of the troops the medics were monitoring placed appropriately on the map. A toggle switch would allow the medic to observe troop location on a topographical map as illustrated or on a grid coordinate-satellite map. Various location descriptors such as grid coordinates, temperature and elevation were also recommended. Medics thought hostile zones should be in red. Color-coded symbols on the map indicate the severity of injury of the troops. In the depiction shown in Figure 2a, a **GREEN SQUARE "■"** indicates the Warfighter is in the **"good to go"** status, a **YELLOW TRIANGLE "▲"** indicates the medic should **"look"** at that Warfighter, a **RED CIRCLE "●"** or flashing red circle (indicated on the Map in Figure 2a by a red sunburst) indicates the medic should **"look now."** The red flashing icon would automatically be displayed if BIDS were activated or the 911 Alert-button were pushed. The **BLUE DIAMOND "♦"** indicates the **"don't know"** status. The medic location is depicted in the figure by a white circle.

The Red Cross **"+"** indicates a Combat Support Hospital or Battalion Aid Station. Rolling the stylus over each symbol would provide the name and roster number of that Warfighter. In addition, distance and direction from the medic to that Warfighter would be displayed when the stylus was positioned on a particular Warfighter. The example in this figure is from the medic to the Warfighter with the green square. Tapping on the symbol would bring up the Individual Warfighter screen for that individual. Clicking on the edge of the map would allow the user to drag the map in that direction. For example, if you clicked on the right side of the map you could drag the map eastward. A quick Auto Center would bring the map back to the default location with the medic centered on the map. There would also be a zoom-in and zoom-out function built in. At the bottom of the screen there would be a clock and some general environmental information about weather, altitude, and date and time displayed.

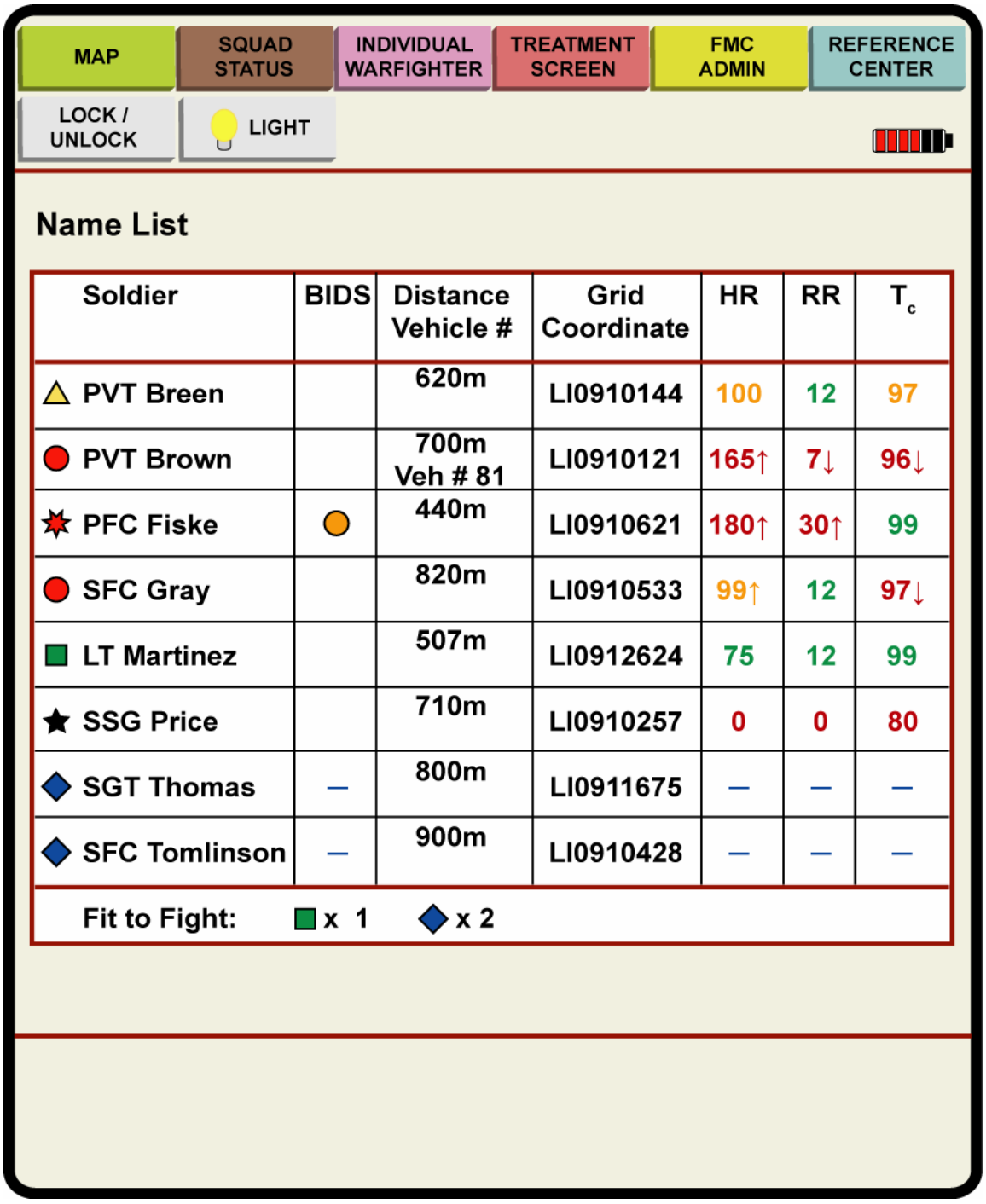
Figure 2b: Screen 2: Squad status



Screen 2- Squad Status

This screen (Figure 2b) would indicate the overall listing of squads with their squad health status color-coded. That is, if the squad as a whole was good to go it would be color-coded green, if the squad was degraded somewhat due to injuries and/or illnesses it would be coded yellow, while if it was degraded severely it would be coded red. If there was insufficient information the squad would be color-coded blue. The general location of the squad would be listed under the grid location to the right of the squad color-coded box.

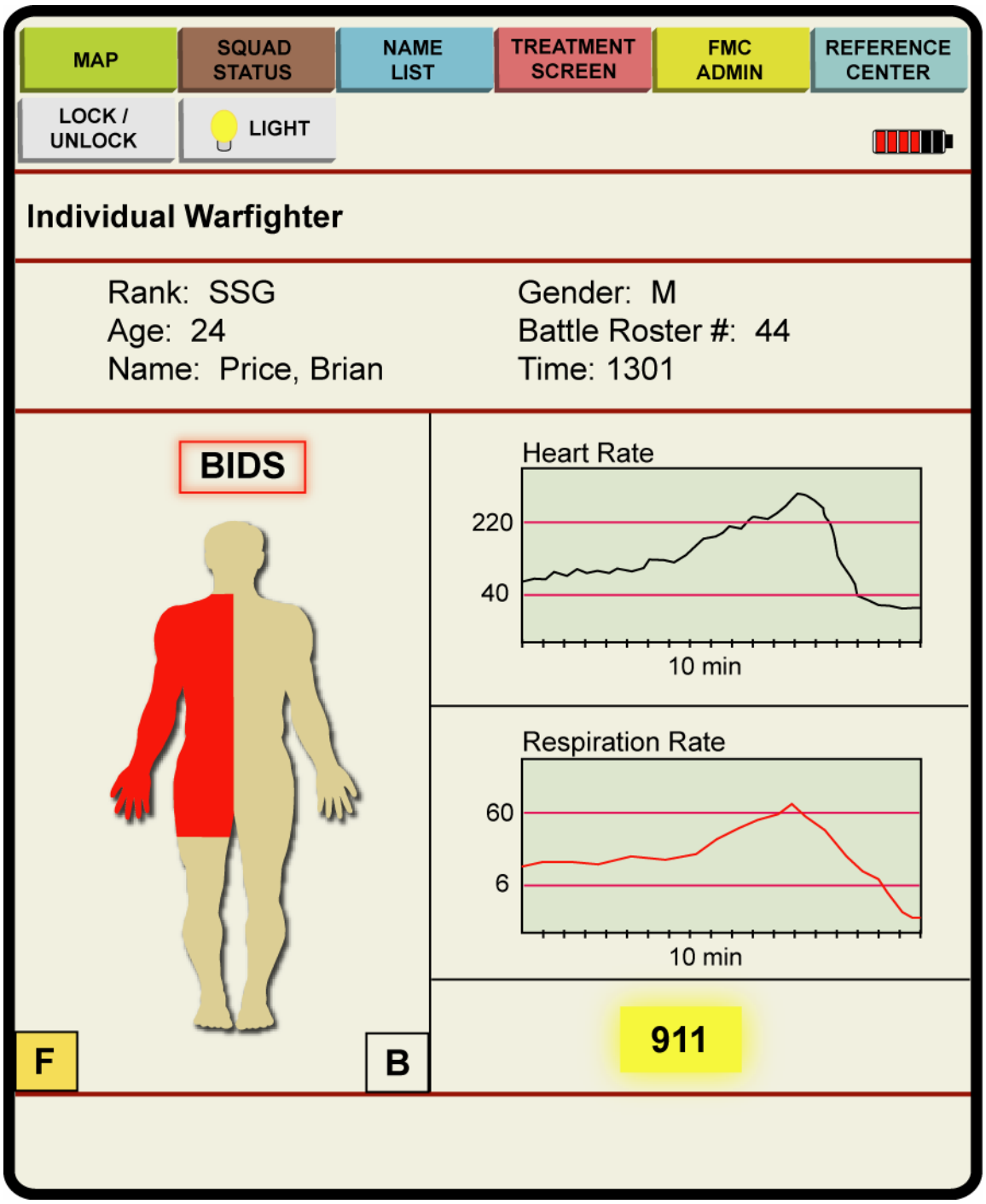
Figure 2c. Screen 3: Name-list with Warfighter health status, geo-location, and vital sign information



Screen 3 - **Name-List With Warfighter Health Status, Geo-Location, and Vital Sign Information**

This screen (Figure 2c) represents an overview of the medical information for all the Warfighters in a particular platoon or squad. Additional names in alphabetical order could be on the screen and could be scrolled down using the PDA's stylus. Warfighters' status as represented on the Map screen would be shown here unless the medic changed the status. In the example here, the medic had entered the "dead code" a black star next to SSG Price. The red sunburst represents a blinking red circle. Medics requested a transition to a red state be immediately conveyed with a blinking red icon. This means that PFC Fiske's status has just changed from green, yellow, or blue to red within the last 2 minutes or so. A blinking red circle would also appear if BIDS were activated or the 911 Alert-button were pushed. After approximately 2 minutes the symbol would turn to a red circle that remains on. Under the BIDS column, the yellow-orange circle next to PFC Fiske means that a BIDS hit was detected indicating PFC Fiske was hit by a bullet or other munitions. Distance is the distance away from the medic to the Warfighter, while vehicle # is the vehicle that Warfighter is with. If no vehicle # is present, it means the Warfighter was not assigned to a vehicle. Grid coordinates indicate the Warfighter's location. For the vital signs of heart rate (HR), respiration rate (RR) and core temperature (T_c) the individual values in beats per minute, breaths per minute and temperature in degrees Fahrenheit would be represented and color-coded. The arrow represents if that particular vital sign is increasing or decreasing. No arrow means that particular value is stable at the value shown on the screen. At the bottom of the screen is a summary of the squads' Fit-to-Fight status, which is a summary of the green and blue coded Warfighters. Tapping on the individual Warfighter's name would allow the medic to proceed to the Individual Warfighter summary screen (Screen 4).

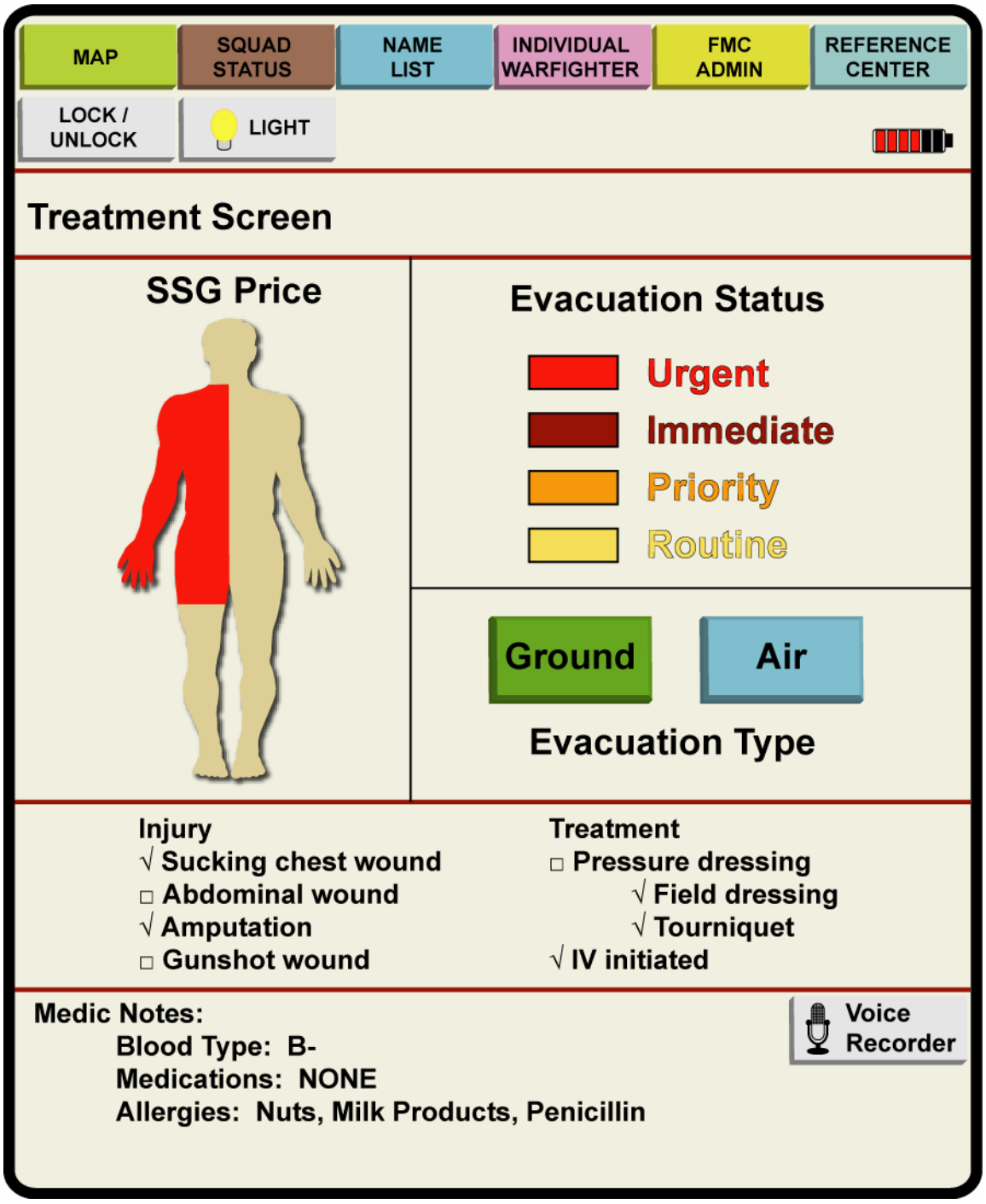
Figure 2d. Screen 4: Individual Warfighter's physiological status



Screen 4 – Individual Warfighter's Physiological Status

This screen (Figure 2d) represents an individual Warfighter's status. Near the top of the screen would be the patient's basic demographic information including their Battle Roster Number. On the left of the screen would be information obtained from BIDS. The red area would represent the likely injured area from a projectile based on the BIDS sensor input. At the bottom would be a light that indicates if the 911 alert-button was pushed. The "F" and "B" buttons at the bottom of the figure would allow the medic to get a front or back graphical view of the injured area. In the example shown here the view is from the front as illustrated by the yellow coloring on the "F" button. On the right side of the screen would be 10 min running graphs of heart rate and respiration rate.

Figure 2e. Screen 5: Treatment administered



Screen 5 – Treatment Administered

This screen (Figure 2e) represents a quick treatment screen. The medic would be able to call for evacuation type (ground vs. air) and how urgent the evacuation must be. Near the bottom of the screen the medic could input some basic information regarding injury characteristics and treatment provided. A checklist of common injuries and illnesses and treatments would be shown with the medic having only to check the boxes of the appropriate responses. In this example, sucking chest wound and amputation were checked off for diagnoses. Application of a field dressing, use of a tourniquet, and IV initiated were checked off for treatments rendered. The lists of injuries and treatments shown are to illustrate examples of what might be provided. The medic notes section of the screen would allow the medic to enter more detailed information in a free-form method using his PDA stylus pen. Within the medic's notes section such information such as allergies could be displayed by inserting the fallen Warfighters' PIC card into the medic's BMIS-T PDA. At the bottom right is a button for voice recorder. Medics recommended that if they didn't have time they could tap this button and their PDA could record via audio input information the medic might not immediately be able to enter using the PDA stylus. For example, if they were working on a patient they could be speaking into their PDA providing information on treatment or the nature of the patient's injuries.

Figure 2f. Screen 6: Field Medical Card – page 1

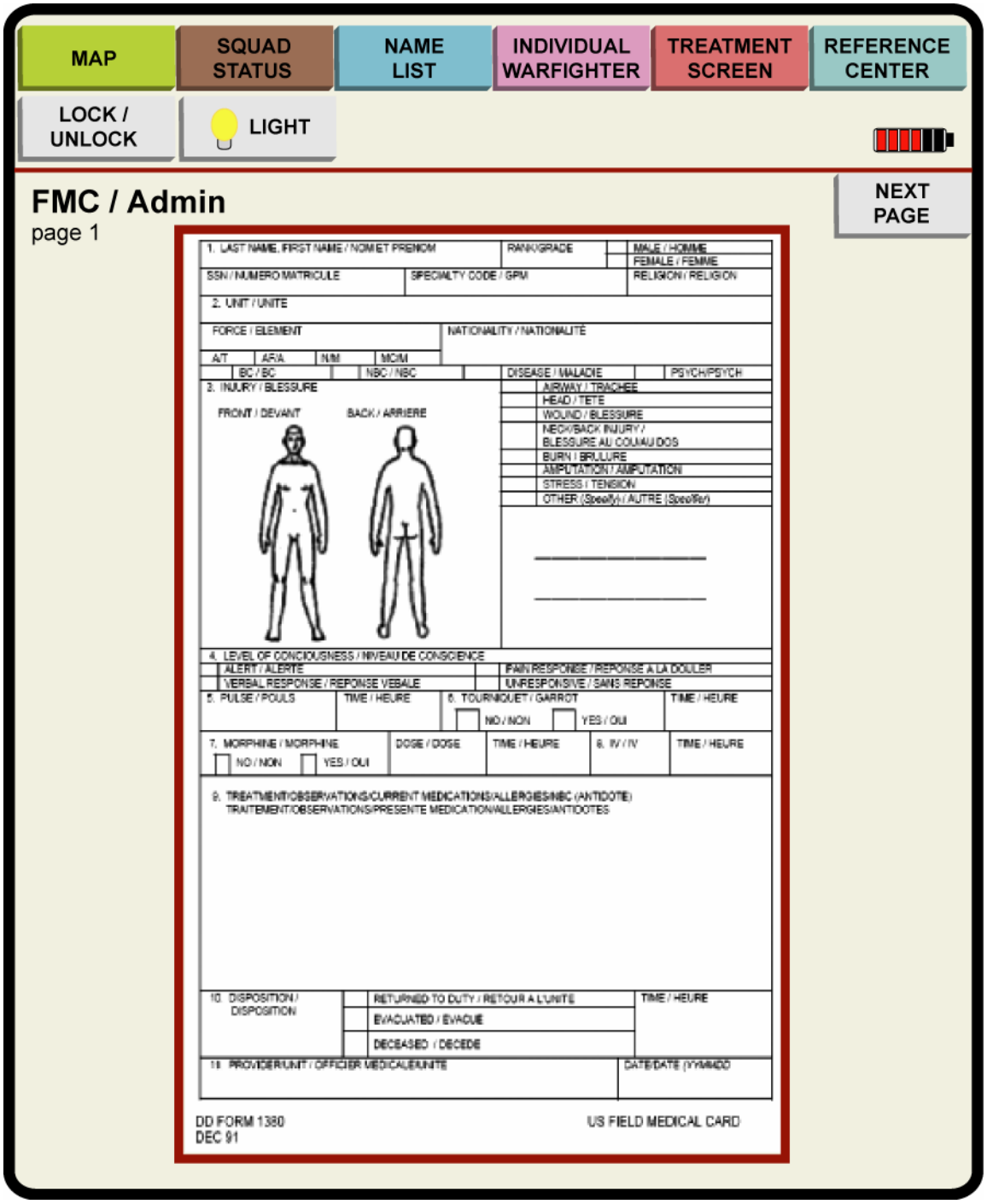
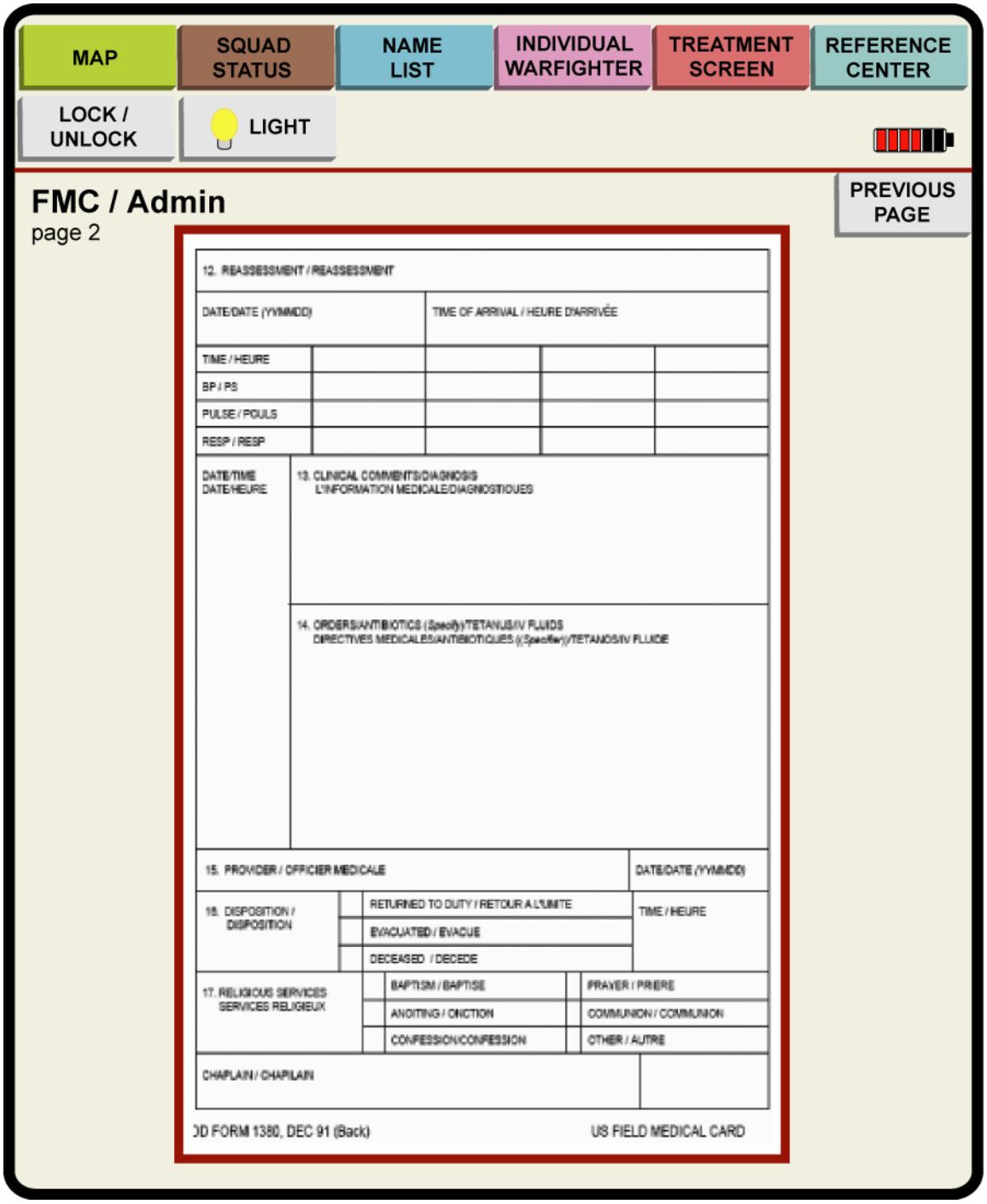


Figure 2f (cont.) Screen 6: Field Medical Card – page 2



Screen 6 – Field Medical Card

This screen (Figures 2f) represents an electronic FMC. This could either supplement or replace Screen 5.

Figure 2g. Screen 7: Reference Center

Screen 7 – Reference Center

This screen (Figure 2g) would be a reference center. Fore example, medical intelligence briefings, region specific illnesses such as malaria, or the Special

Operations Forces Medical Handbook (2001) could be made available. Other suggestions included recommended treatments for various injuries and recommendations on medications for various illnesses. A language translator with the necessary languages for the deployed area could be loaded onto the PDA and accessed through this screen.

DISCUSSION

This report documents what combat-experienced medics deem important information in patient care and how they would like to see this medical information displayed for the future WPSM systems. The GUI display on the BMIS-T must allow the medic in the field to use the information from the WPSM system in rapid decision making. Without acceptance and utility from the medic, the physiological recording of the information would be of little value.

The prototype graphical display cited by Hoyt and Friedl (2004) has many acceptable features recommended by the medics who provided GUI feedback during this study. There were limitations and some bias towards designs developed from USARIEM, TATRC, and Dartmouth College GUIs because medics were shown those designs before they were asked for their recommendations. This was done to provide a framework of what was possible with GUI designs. In addition, the designs were limited based on available technology. However, all medics believed that a WPSM system with an icon-based GUI on a PDA BMIS-T would be a useful tool when treating casualties during combat.

From the focus group sessions, medics indicated that it is very important that they could input information into the BMIS-T such as medical diagnoses and treatments and to have an electronic FMC. Furthermore, the system should allow medics to update the status of a Warfighter. For example, a Warfighter that returns to the battlefield after being treated has a green code with a special designator that he has been cleared by the medic. Related to life sign status, three of the four focus groups stated that they did not want the WPSM system characterizing a Warfighter as dead (Black Code) but that they could input into the system the dead code (Black Code) after a patient was examined and pronounced dead. However, one focus group believed that if the WPSM system truly was valid and reliable at determining who was dead and alive, the Black Code should be used to designate a dead Warfighter.

It appears most medics want a way of assessing troop location, have a summary screen such as a name-list screen that summaries the medical condition of the troops they are monitoring, want a detailed patient screen where they can assess the individual physiological signs of a patient, and finally have an electronic version of the Field Medical Card (FMC). While there were some variations between focus groups on how each of these screens should look, these variations were small.

Some of the individual GUI designs and designs that were agreed upon in focus group sessions had some features included that were not available in the WPSM system. They were included despite the moderators telling the medics what was and was not available. For example, many medics requested that pulse oximetry and blood pressure be included even though they knew these two vital signs were not available as part of the WPSM system. When questioned, they told the moderators to put these vital signs down anyways because these are technologies that should be developed next as part of a useful WPSM system. This information may be used as a guide for future developmental work in physiological monitoring. Medics said these are two critical vital sign pieces of information they use to treat casualties in the field. Medics wanted a wide range of vital sign information before they arrived for their on-site evaluation. Vital signs they would like to have would include heart rate or pulse, respiration, core temperature, pulse oximetry, and blood pressure. These vital signs corroborate recommendations of Ranger Training Brigade medics monitoring Ranger trainees when asked what vital sign information they needed to treat patients during training or combat (Tharion and Hoyt, 2004).

While these GUIs were those recommended by medics in this study, they were done in the abstract. Medics have not actually used screens designed like this. We recommend that before these GUIs are formalized for use with the WPSM system, prototypes of the screens with the characteristics described within this report be constructed and a study of medics trying to use these screens in a simulated casualty treatment experiment be conducted. The purpose of such an experiment would be to determine if the GUI designs constructed with the recommendations contained in this report actually meet the medic's needs and performance expectations. By conducting such an experiment it would ensure that various human factors issues of using such a system are addressed; making sure that the GUIs are not too complex or result in cognitive overload.

Overall, medics embraced the idea of the WPSM system being a tool that allowed them to do their job more efficiently and effectively. However, they do not feel technology can serve as a replacement for well trained combat-tested medics. The results from this study provide documentation from an experienced user community on what information is important and how to display the medical information obtained from the WPSM system.

CONCLUSIONS

- The results from this test illustrate that most medics are receptive to the general concepts presented in the WPSM GUI's shown in Figures 2a-2g.
- The information sought by medics can be condensed into 6 or 7 screens.
- Geo-location and color-coded life-sign status were rated as the most important information to display.

- Having measures of circulation (heart rate or pulse rate) and respiration (respiration rate) were considered to be the two most vital sign categories of information that should be represented.

- Evacuation status was important. It was recommended that a distinction be made between those transported out by ground versus air.

- Information should be summarized and linked to higher or appropriate levels. For example, squad or platoon strength should be summarized and sent to command staff. Medical evacuation information should be sent to the appropriate medical evacuation unit that will be responsible for removing the casualty from the battlefield. Finally, medical information about treatments and vital signs should travel with the wounded Warfighter to the location of next higher level of care.

- The BMIS-T must allow easy recording of medical notes regarding diagnosis of injury and treatment provided.

RECOMMENDATIONS

It is recommended that the findings within this report be used by developers of the WPSM GUI system. These results are from the end-user community, i.e., the combat experienced field medic, and if these recommendations are incorporated into the GUI designs it is likely that greater product acceptability is likely to occur. Before incorporation into a product that is fielded, a study should be conducted to ensure that the designs generated in the abstract actually work for the intense battlefield environment.

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APPENDIX A

Medic's Medical Information Survey

Purpose: We would like to understand what information you as medics need to help prevent and treat injuries and casualties during training and combat. This questionnaire will ask you briefly about your experience and training as a medic and some questions about the information that you require to best manage and treat Soldiers during combat and training. All questionnaires will remain anonymous; therefore do not put your name on the survey. Please put the identification number we give you on the survey.

Background Questions

1. Questionnaire Number _____

2. Years in Service _____

3. Current Military Occupational Specialty (MOS) _____

4. Do you have any civilian experience as an Emergency Medical Technician (EMT) or Paramedic?
(Please Circle Your Response) Yes No

5. If yes, to question 4, how many years? _____
(If no skip to Question 6)

6. Have you been in combat? Yes No
(Please Circle Your Response)

7. If you have been in combat, how many tours? _____
(Skip to question 10 if you have not been in combat)

8. What combat locations have you been deployed to? _____

_____

9. What type of medical facility were you primarily stationed at during your combat tours (check all that apply).

Combat Support Hospital	_____	Battalion Aid Station	_____
Area Support Medical Company	_____	Line Medic	_____
Forward Support Battalion		Other	_____
Treatment Platoon	_____		
Ambulance Platoon	_____		

If other please list _____

10. What is your present duty station and unit?

Duty Station _____

Unit _____

11. How long have you been at this duty station? _____

12. If present duty station is less than 1 month please list previous duty station and unit and time spent at that duty station? (If present duty station is longer than 1 month skip to question 13)

Previous Duty Station _____

Previous Unit _____

Time Spent at Previous Duty Station _____

13. How many hours per week do you currently spend in doing patient/Soldier care?

_____

14. What type of Soldiers do you normally treat (Check all that apply)?

Aviators	_____	Special Operations	_____
Mechanized Units	_____	Other (Please Specify)	_____
Light Infantry	_____		

Medical Information During Unit Training

15. What are the top three injuries/illnesses that you have observed/treated during unit training?

15a. _____

_____

15b. _____

_____

15c. _____

_____

16. For each of the injuries/illnesses listed in 15a to 15c, what information do you need? For question 16a please put the information that would be needed to diagnose, treat, and monitor the injuries/illnesses listed in 15a, etc.

16a._____

_____

16b._____

_____

16c._____

_____

17. What information as a medic do you collect or need to prevent injuries/illnesses to maintain the unit's health and readiness? _____

_____

_____

If you have not served during combat you have completed the questionnaire and may turn it in. If you have served during combat please complete the following section.

During Combat

18. During combat do you need past medical or surgical history information?
(Please Circle Your Response)

Yes No

19. If you answered yes to question 18, please state specifically what you would find helpful.
(Skip to Question 20 if you answered No to Question 18)

_____

_____

20. What information do you collect or need to prevent injuries/illness during combat to maintain the unit's health and readiness? _____

_____

21. What are the top three injuries/illnesses you have observed/treated during combat?

21a. _____

_____

21b. _____

_____

21c. _____

_____

22. For each of the injuries/illnesses listed in 21a to 21c, what information do you need? For question 22a please put the information that would be needed to diagnose, treat, and monitor injuries/illnesses listed in 21a, etc.

22a._____

_____

22b._____

_____

22c._____

_____

23. When you have multiple casualties how do you determine who you treat first?

_____

_____

_____

24. What information do you need or would like to have in order to make the assessment on who you treat first?

_____

_____

_____

25. Describe a personal incident during combat where you felt if you had a particular device, a piece of medical information, or specific vital sign, that it would have made a major difference in your treatment or the Soldier's medical outcome.

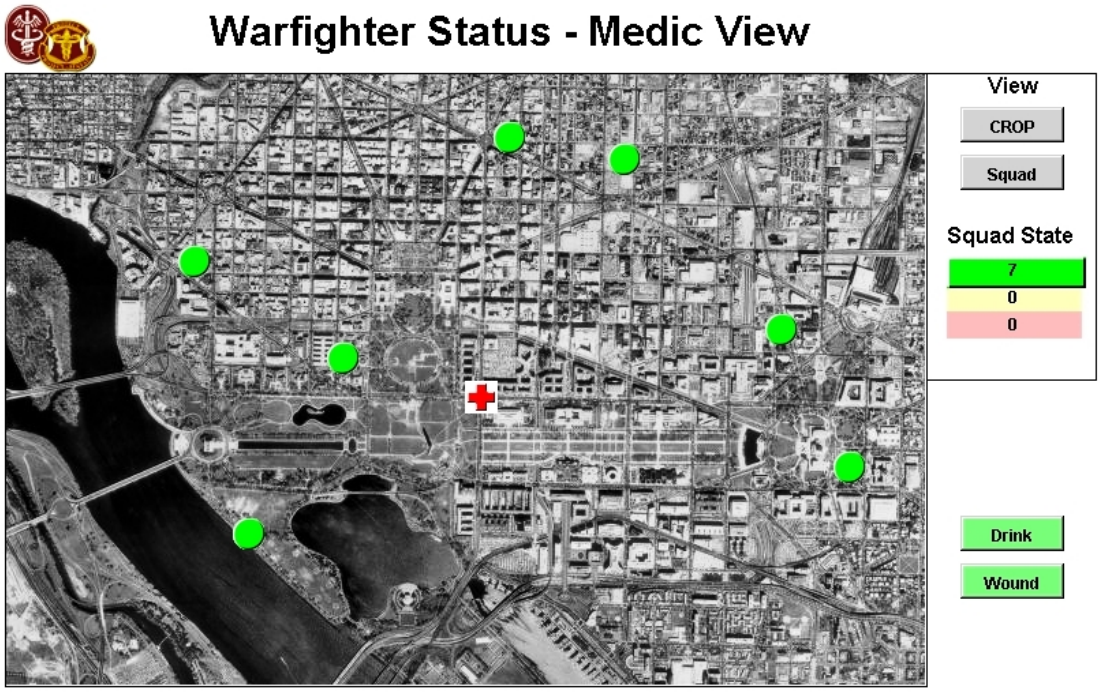
_____

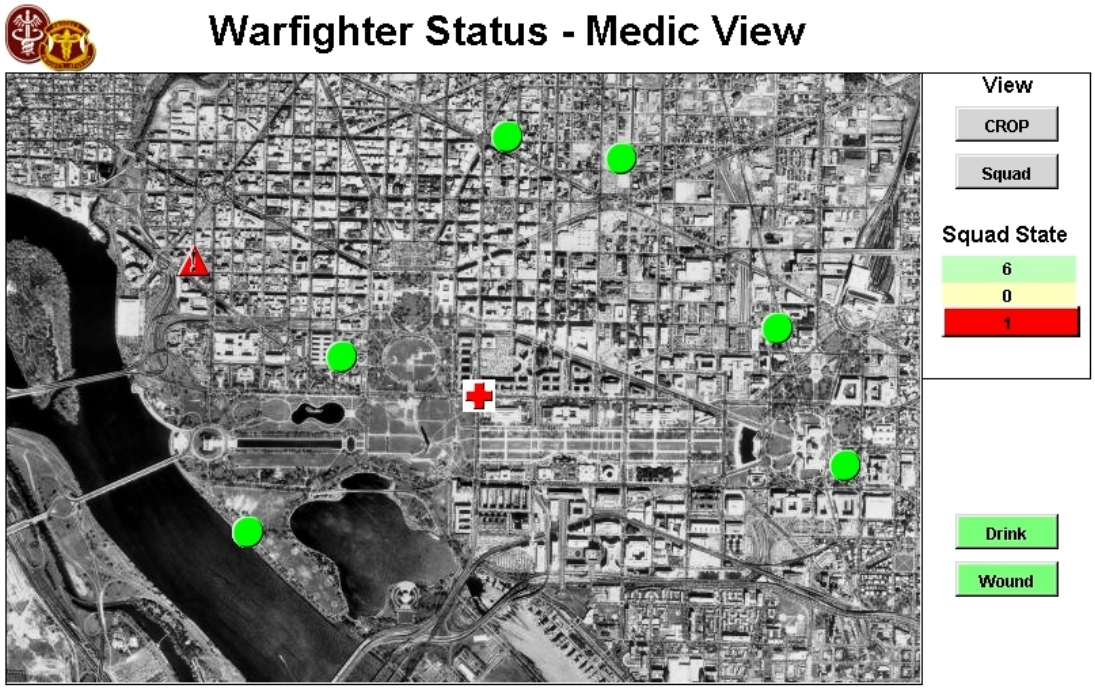
_____

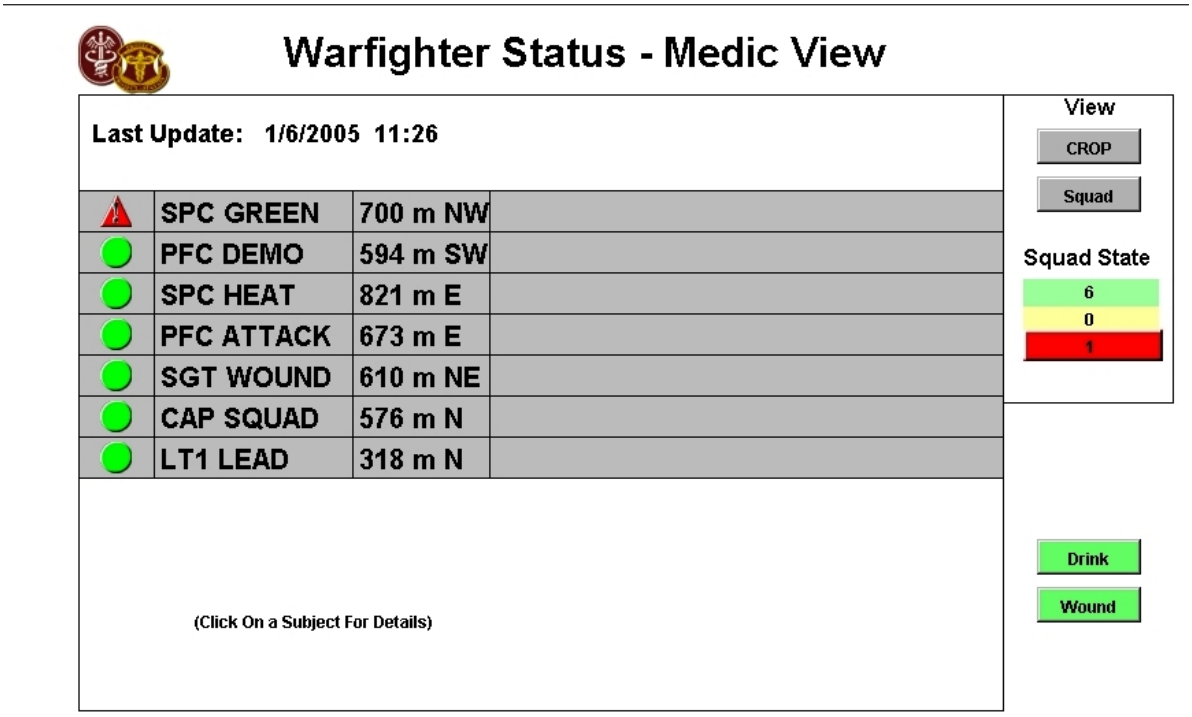
_____

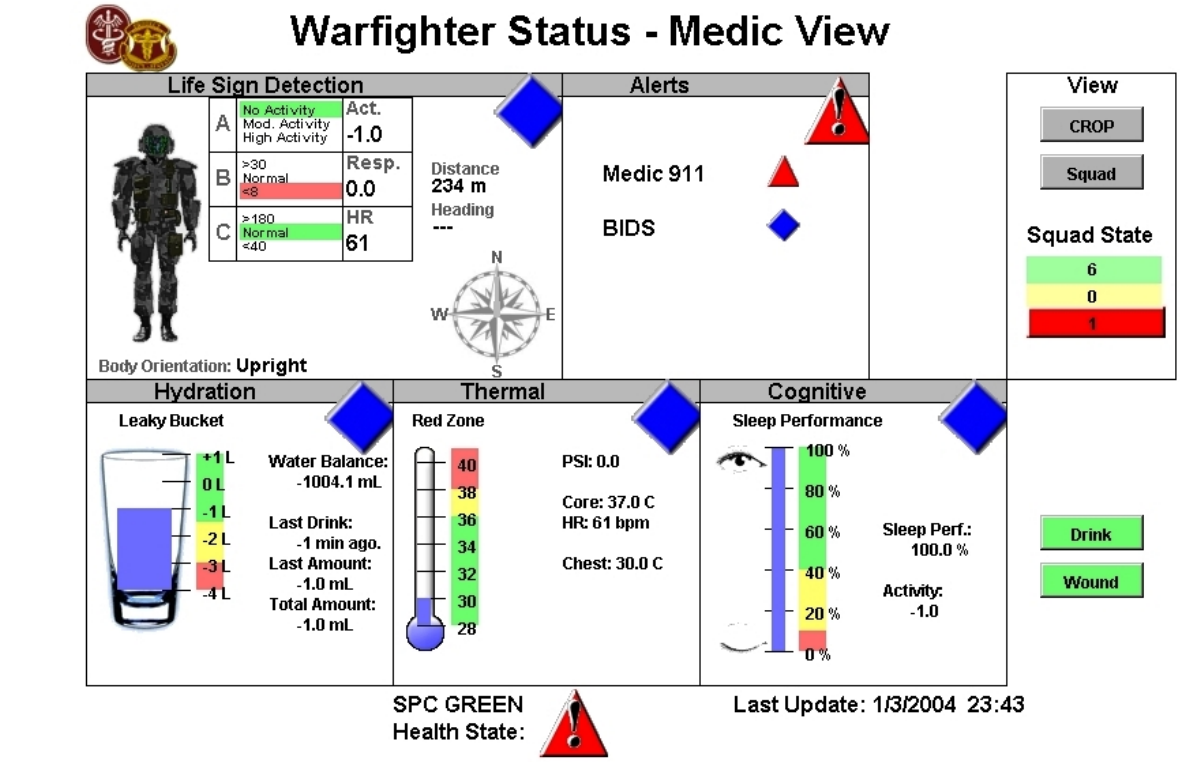
APPENDIX B

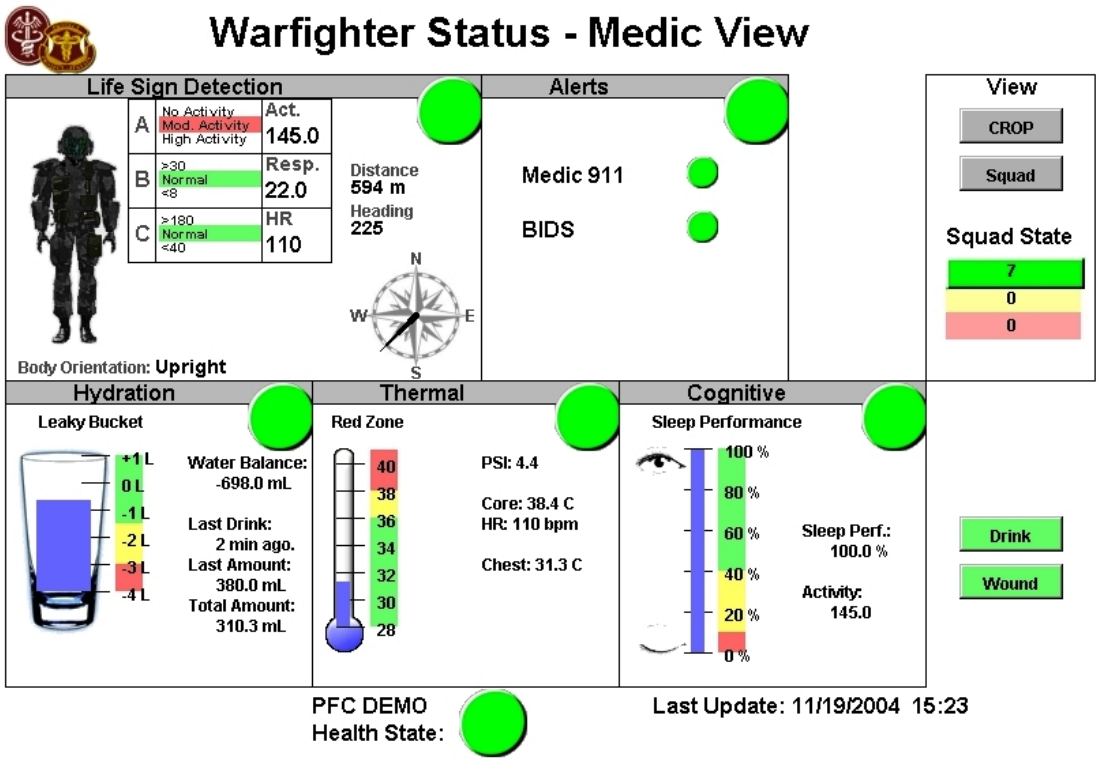
USARIEM Graphical User Interface Design






Warfighter Status - Medic View
Last Update: 1/6/2005 11:26
SPC GREEN 700 m NW
PFC DEMO 594 m SW
SPC HEAT 821 m E
PFC ATTACK 673 m E
SGT WOUND 610 m NE
CAP SQUAD 576 m N
LT1 LEAD 318 m N
(Click On a Subject For Details)
View
CROP
Squad
Squad State
6
0
1
Drink
Wound


Warfighter Status - Medic View
Life Sign Detection
A No Activity Mod. Activity High Activity Act. -1.0
B >30 Normal <8 Resp. 0.0
C >180 Normal <40 HR 61
Distance 234 m
Heading ---
N W E S
Body Orientation: Upright
Alerts
Medic 911
BIDS
View
CROP
Squad
Squad State
6
0
1
Hydration
Leaky Bucket
+1 L 0 L -1 L -2 L -3 L -4 L
Water Balance: -1004.1 mL
Last Drink: -1 min ago.
Last Amount: -1.0 mL
Total Amount: -1.0 mL
Thermal
Red Zone
40 38 36 34 32 30 28
PSI: 0.0
Core: 37.0 C
HR: 61 bpm
Chest: 30.0 C
Cognitive
Sleep Performance
100 % 80 % 60 % 40 % 20 % 0 %
Sleep Perf.: 100.0 %
Activity: -1.0
Drink
Wound
SPC GREEN
Health State:
Last Update: 1/3/2004 23:43


Warfighter Status - Medic View
Life Sign Detection
A
No Activity
Mod. Activity
High Activity
Act.
145.0
B
>30
Normal
<8
Resp.
22.0
C
>180
Normal
<40
HR
110
Distance
594 m
Heading
225
N
W
E
S
Body Orientation: Upright
Alerts
Medic 911
BIDS
View
CROP
Squad
Squad State
7
0
0
Hydration
Leaky Bucket
+1 L
0 L
-1 L
-2 L
-3 L
-4 L
Water Balance:
-698.0 mL
Last Drink:
2 min ago.
Last Amount:
380.0 mL
Total Amount:
310.3 mL
Thermal
Red Zone
40
38
36
34
32
30
28
PSI: 4.4
Core: 38.4 C
HR: 110 bpm
Chest: 31.3 C
Cognitive
Sleep Performance
100 %
80 %
60 %
40 %
20 %
0 %
Sleep Perf.:
100.0 %
Activity:
145.0
Drink
Wound
PFC DEMO
Health State:
Last Update: 11/19/2004 15:23

APPENDIX C

Dartmouth College Graphical User Interface Design

Alternate Detailed Info Screen

- "Night Mode" - High contrast display for easier viewing in low-light conditions, or from a distance.
- Simplified trending information for quantitative status
  - Current Values
  - Deviation from normal (elevated, normal, depressed)
  - Rate of change (Stable, Falling, Rising)
- Removal of graph view allows for faster (though less detailed) analysis of data trending.

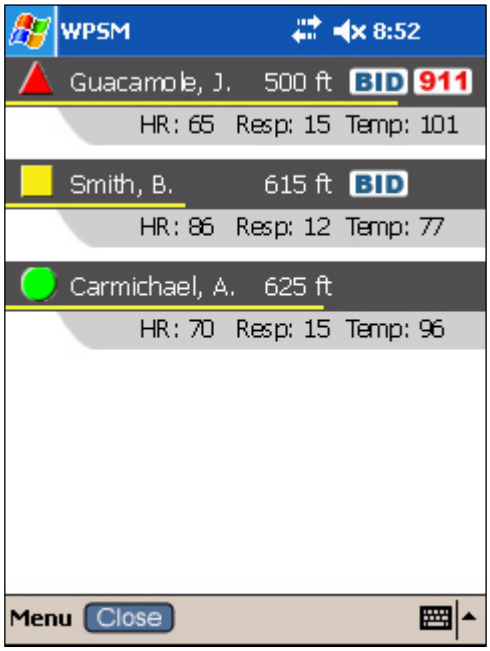
APPENDIX D

TATRC Graphic User Interface Design

LIST SCREEN

Notes:

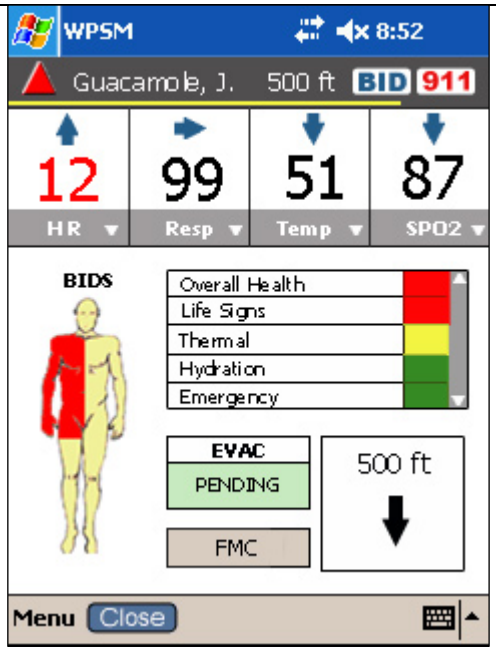
- Close button will take the user back to the main BMIS-T Screen
- The grey bar (details bar), underneath the name can be shown or hidden via an option in the menu
- The yellow lines will shown time since the last SDO was received.
- The BID and 911 alerts will only be visible when a BID or 911 event occurs.



DETAILS SCREEN

Notes:

- The numeric boxes will be defaulted to the most commonly used numeric. The user will be able to change the viewed numeric by selecting from a drop down list.
- Will the BIDS be based upon none, left, center, right? How should the BIDS model be shaded?
- What should be shown in the "Evac" Box?
- Close button would take user back list Screen.



APPENDIX E

DETAILED BACKGROUND MEDICAL AND COMBAT INFORMATION ON MEDIC VOLUNTEERS

MEDIC CLINICAL INFORMATION

Medic volunteers in this study had been in the military 9.1 ± 5.1 yrs. All but one medic had combat experience (24 in Iraq, 5 in Afghanistan, 1 each in Kuwait, Somalia, and Haiti). Some had more than one tour of duty (i.e., 4 had two tours and 1 had 3 tours) accounting for the $n > 25$. The clinical experience for the medics during combat occurred primarily as line medics stationed with mechanized units or light infantry units, or working at a Battalion Aid Station. Table E1 summarizes the clinical experience these volunteers possessed as combat medics. In addition to their military medical experience, six medics had civilian Emergency Medical Technician (EMT) experience (5.5 ± 4.7 yrs, for those with experience). While in their current duty positions, only 15 (57.8%) of the medics were currently providing clinical care (between 11 and 45 hours per week) primarily to students taking military training courses. All medics were currently instructors or attending courses at Ft. Sam Houston, TX or working at the Kirk Army Clinic at Aberdeen Proving Ground, Aberdeen, MD.

Table E1. Clinical experience of medics while in combat

Medical Facility Stationed at During Combat	Frequency	% of Total
Line Medic	17	68.0
Battalion Aid Station	15	60.0
Forward Support Ambulance Platoon	10	40.0
Combat Support Hospital	2	8.0
Forward Support Battalion Treatment Platoon	2	8.0
Area Support Medical Company	1	4.0
Special Operations Medic	1	4.0
Advanced Trauma Life Support Team	1	4.0
Flight Medic	1	4.0
Casualty Collection Checkpoint	1	4.0
Battalion Surgeon's Assistant	1	4.0
Forward Extraction Team	1	4.0

TRAINING INFORMATION

Medics were asked to list the "Top 3" most frequently treated or observed injuries or illnesses during training and the information they needed to treat these injuries or illnesses. The most frequently reported injuries or illnesses were fractured bones and upper respiratory illnesses. Table E2 is a list of all the injuries and illnesses these medics reported as being in the "Top 3" most frequently treated or observed during training. Not all volunteers mentioned three different injuries or illnesses encountered during training.

Table E2. Frequency of training illnesses and injuries observed by medics

Training Injuries	Frequency	% of Total
Fractured bones (not including stress fractures)	7	26.9
Upper respiratory illness	7	26.9
Heat injuries (including heat stroke/heat exhaustion)	6	23.1
Major and minor lacerations/cuts	6	23.1
Sprains/strains	5	19.2
Lower extremity injuries (general)	5	19.2
Back pain/injuries	5	19.2
Dehydration	5	19.2
Injuries from falls	4	15.4
Gastrointestinal problems (nausea, vomiting, diarrhea)	4	15.4
Anaphylactic shock	2	7.7
Stress fractures	2	7.7
Contusions	2	7.7
Finger injuries	2	7.7
Skin irritations	1	3.8
Cold injuries	1	3.8
Soft tissue injuries	1	3.8
Upper extremity injuries (general)	1	3.8
Nasal congestion	1	3.8
Daily sick call complaints	1	3.8
Kidney stones	1	3.8
Malingering	1	3.8
Ingrown toenails	1	3.8
Low blood pressure	1	3.8

The information needed by medics for diagnosis, treatment, and monitoring of the above conditions has been tabulated in Table E3. A percent of total is not listed for this table because a medic might have listed a particular piece of information needed more than once. The most important information cited most frequently to treat the above mentioned injuries and illnesses is: a) does the patient have a pulse, b) what is the pulse rate, and c) what was the likely cause of the injury or illness.

Table E3. Frequency of information categories or types medics report needing to treat injuries and illnesses encountered during training

Training Injuries	Frequency
Pulse (circulation)	11
Mechanism of injury or illness (events leading up to incident)	10
Severity and location of pain	6
Core temperature	6
Patient medical history (including current medications)	6
All vital signs	5
Hydration status/fluid intake	5
Information obtained from X-Rays	5
Information on patient allergies	4
Blood pressure	4
Respiration	4
Oxygen saturation levels (pulse oximetry)	3
Blood loss	3
Premenstrual syndrome information	3
Visual inspection of injuries	3
Heart rate	2
Tilt test information	2
Access to proper medications	2
Length of time sick or injured	2
Any nasal discharge	2
Treatments provided	2
Is patient coughing or lung sounds/congestion	2
Urine output (including color, odor and consistency)	2
Patient moving	2
Knowledge of medications	1
Physician or physician's assistant allowing medic to give Hands-on treatment (i.e., practice needed)	1
Ambient temperature	1
Patient conscious (level or loss of consciousness)	1
Information on patient asthma	1
Knowledge of treatment options	1
Mental state of the patient	1
Duration of illness or injury	1
Bowel movements	1

When asking what information was needed, some medics listed medical equipment instead of information. Those responses have been separated out and are listed in Table E4.

Table E4. Frequency of medical equipment categories or types medics report needing to treat injuries and illnesses encountered during training

Training Injuries	Frequency
Stethoscope	2
Equipment for stabilizing the back and neck (e.g., short and long boards, litter, straps, neck braces)	1
Audioscope	1
Access to proper medical equipment	1
Tongue depressor	1

When asked what information is needed in order to maintain the unit's health and readiness during training; medics most frequently stated they needed a) access to a patient's past medical history, b) information on patient allergies, c) who is on medications, and d) immunization records of the troops. A complete list of all information cited by medics to maintain unit readiness is listed in Table E5.

Table E5. Frequency of information categories or types medics report needing to maintain unit readiness during training

Information Needed	Frequency	% of Total
Patient medical history (past injuries, illnesses and surgeries)	9	34.6
Patient allergies	9	34.6
Current medications	8	30.8
Immunization record	6	23.1
On-profile	4	15.4
Work-rest cycles	3	11.5
Past hot or cold weather injuries	3	11.5
Ability to monitor blood pressure	2	7.7
Ability to monitor pulse (circulation)	2	7.7
Ability to monitor airway stability	1	3.8
Ability to monitor core temperature	1	3.8
Ability to monitor oxygen saturation levels (pulse oximetry)	1	3.8
Ability to monitor blood loss and/or fluid loss	1	3.8
Master list of all Soldiers on PDA organized by medical liabilities (e.g., on-profile, allergies, on medications)	1	3.8
Specific information on type of unit monitoring	1	3.8
Weather reports	1	3.8
Ability to monitor respiration rate	1	3.8
Proper literature to diagnose problems that commonly occur in the field (e.g., insect protection, heat injury, etc.)	1	3.8
Location of troops on training site so when needed to be treated know where they are	1	3.8
Ability to monitor hydration state	1	3.8
Information on patient's resting/baseline physiology	1	3.8
Information on food intake (when, what, where, etc.)	1	3.8

COMBAT INFORMATION

The types of patients treated most often were light infantry Soldiers as seen in Table E6. When asked about the need for past medical history or surgical information to treat combat injuries, 53.8% of medics responded they needed that information to provide proper care. The type of medical information that would be needed most was information regarding allergies. Table E7 reports the frequency of each response reported by the 14 medics who said they needed information. Percent of total is not listed for this table as some medics stated more than one piece of information is important while 46.2% of the medics stated that past medical or surgical history information was not important in treating the wounded during combat.

Table E6. Frequency of types of patients treated during combat

Combat Injuries	Frequency	% of Total
Light Infantry Soldiers	11	44.0
Mechanized Unit Soldiers	7	28.0
Special Operations Soldiers	4	16.0
Support Unit Soldiers	4	16.0
Aviators	3	12.0
Iraqi Soldiers	1	4.0
Civilians	1	4.0

Table E7. Frequency of past medical or surgical information categories or types reported as being helpful to have during combat

Information Needed	Frequency
Allergies	5
Medications	3
Eyesight issues	2
Past surgeries	2
Any existing illness	2
Heat injuries	2
Blood pressure (high or low) history	2
Major trauma history	2
Any organs removed	1
Any transplants	1
Cold injuries	1

When medics were asked for the “Top 3” combat injuries they observed and/or treated, they reported gun shot wounds and wounds from improvised explosive devices (IEDs) as the most common responses. The responses to this question are somewhat ambiguous because some responses referred to the injury cause, e.g., an IED injury, and some to the injury itself, e.g., a burn or head injury. Nevertheless, from Table E8, it may be observed that the most frequent injuries observed and treated by medics during combat came from ballistic impacts of various munitions. The type of injuries most often

Table E8. Frequency of combat illnesses and injuries observed by medics

Combat Injuries	Frequency	% of Total
Gun shot wounds	17	68.0
Improvised explosive device (IED) shrapnel and/or blast injuries	15	60.0
Amputations (traumatic/loss of limb)	11	44.0
Lower extremity injuries	10	40.0
Chest injuries	7	28.0
Burns	6	24.0
Upper extremity injuries	5	20.0
Major and minor lacerations/cuts	4	16.0
Gastro-intestinal/lower abdominal injuries	4	16.0
Heat injuries (including heat stroke/heat exhaustion)	3	12.0
Motor vehicle injuries	3	12.0
Head injuries (including concussions)	2	8.0
Dehydration	2	8.0
Gastrointestinal problems (nausea, vomiting, diarrhea)	2	8.0
Fractured Bones (not including stress fractures)	1	4.0
Bleeding	1	4.0
Facial injuries	1	4.0
Neck injuries (including jugular laceration)	1	4.0
Crush injuries	1	4.0
Daily sick call complaints	1	4.0
Perforated eardrum	1	4.0
Perforated sinus cavity injury	1	4.0
Malaria	1	4.0
Avulsion to scalp	1	4.0
Soft tissue injuries	1	4.0
Upper respiratory illness	1	4.0

reported were amputations followed by various lower extremity injuries. The information needed by medics for diagnosis, treatment, and monitoring was the anatomical location of the injury and blood pressure information (Table E9). Again, percent of total is not listed because some information was listed more than once depending on the injury. Also, similar to when asked about training injuries and illnesses, some medics when asked about what information they needed stated medical equipment needed to treat combat injuries and illnesses. These responses have been tabulated separately in Table E10. Tourniquets were the device most often cited.

Table E9. Frequency of information categories or type medics report needing to treat injuries and illnesses encountered during combat

Training Injuries	Frequency
Blood pressure	18
Location of wounds including visual inspection of entry and exit locations of bullets and other munitions	18
All vital signs	15
Respiration	12
Pulse (circulation)	12
Blood loss	11
Mechanism of injury or illness (events leading up to incident)	9
Extent of injuries	9
Core temperature	8
Patient conscious (level or loss of consciousness)	8
Blood and/or body fluid volume	7
Heart rate (electrocardiogram-ECG)	7
Oxygen saturation levels (pulse oximetry)	6
Length of time sick or injured (time of injury)	6
Airway status	5
Tidal volume	4
Hydration status/fluid intake	4
Information obtained from X-Rays	2
Blood gases	2
Stress level	2
Chest movement	2
Age	2
What if any medical attention has already been administered	2
Premenstrual syndrome	1
Personal hygiene	1
Amount of food consumed	1
Time of last tetanus shot	1
Patient medical history (including current medications)	1
Continued relevant medical training	1
Location of patient (distance away)	1
Patient moving	1
Ability for quick evacuations	1
Information on external jugular quality	1
Activity undertaken when injury or illness occurred	1
Prior heat injuries	1
Ambient temperature	1
Any nausea, vomiting, diarrhea	1
Skin color	1
Have nursing skills	1

Table E10. Frequency of medical equipment categories or types medics report needing to treat injuries and illnesses encountered during combat

Training Injuries	Frequency
Tourniquets	6
Israeli bandage	4
Aid bag	3
Something to sterilize instruments	2
General medical supplies (good re-supply)	2
Replacement fluids (intravenous (I.V.) and oral)	2
Sherman chest seal	1
Ear plugs	1
Spine immobilization equipment	1
Tilt test	1

When medics were asked about how to best maintain the unit's health and readiness the most frequently cited information needed was access to a Soldier's past medical history. The complete list of the responses is shown in Table E11.

Table E11. Frequency of responses regarding information necessary to maintain unit health and readiness during combat

Information Required	Frequency
Past medical history	7
Hydration status	6
Allergies	5
Prior heat injuries	5
Medications	4
Prior cold injuries	4
Nutritional habits	3
Hygiene habits	2
Have proper medical equipment	1
Have proper training (not book)	1
Proper Warfighting skills of unit	1
Know your enemy	1
Water source information	1
Insect information about area	1
Stress level	1
Alertness level	1
Field sanitation	1
Information on illnesses linked to area	1
Mental and physical health status	1
Vaccination history	1
Taking preventive medication measures	1
Information on eyesight	1
Work/rest cycles	1

TRIAGE INFORMATION

In situations with multiple casualties, when medics were asked about how they make a determination on who to treat first, they said it was based on the severity of injuries; life, limb, eyesight, and medical ABCs (airway, breathing, and circulation). Determination is usually made when a medic can see his or her patient. That is, triage information is made once a medic is at the scene of the casualty. If there are multiple casualties within eye's view, then triage principals as stated above are applied. One medic made the distinction at combat level of care and tactical care. He stated he would go "to the casualty closest to him if under fire, but if not under fire, he would treat the patient with the most serious triaged injury." Another medic stated that sometimes "it depends on the supplies available." "If you don't have the tools to treat a particular injury you treat what you can." Table E12 summarizes the triage procedures medics use in a mass casualty situation, whereas Table E13 shows the information needed by medics to make triage assessments.

Table E12. Medic's triage procedures

Procedure	Frequency
Severity and extent of injuries (life, limb, eyesight)	8
Ability to assess airway, breathing, circulation (ABCs)	4
Closest to you if life saving techniques will work	3
Level or loss of consciousness	3
Who has the best chance of surviving	3
Use mass casualty training principles (normal triage principles)	3
Those yelling and alert treated later	2
Body movement (yes/no)	2
Delayed, immediate, minimal, expectant classifications	2
Mental status of patient	2
Evacuation resources	1
Medications on site	1
Anatomical location on the body of injury	1
Blood loss	1
Vital signs (e.g., pulse, breathing, pulse oximetry, blood pressure)	1
Mechanism or cause of injury	1

Table E13. Information needed by the medic to determine who to treat first

Information Needed	Frequency
Vital signs (including pulse, breathing, pulse oximetry, blood pressure)	15
Anatomical location and type of body of injury	7
Severity and extent of injuries (life, limb, eyesight)	5
Level or loss of consciousness	4
Mechanism or cause of injury	4
Ability to assess airway, breathing, circulation (ABCs)	3
Blood loss	3
Time of injury	2
Mental status	2
Evacuation resources	1
Use of WPSM algorithms	1
Medications on site	1
Number of casualties	1

SPECIFIC INCIDENT INFORMATION

In describing personal incidents where a particular device or information would have made a major difference in Soldier care, the predominant theme was having devices or information that would allow the medic to better diagnose the problem. Often it seemed that the medic would state they could have treated the patient better if only they knew what the problem was. Sometimes this involved actual communication issues. Examples of experiences medics provided included:

- One medic stated that he was told he was getting a patient with a gun shot wound to the leg, but when the patient showed up it was an untreated bilateral leg amputation.
- A second medic stated that he was treating a Soldier for a broken arm and leg in a lead vehicle of a convoy while back in the convoy there was a more critically injured Soldier he never knew about until much later after he had finished treating the Soldier in the lead vehicle.
- A third medic stated knowing the type of injury is important because I.V. bags weigh you down, and you want to make sure you have enough on you but not to have to carry too much. Carrying too much slows you down when you are trying to reach a downed Soldier in the field as fast as you can.
- A fourth medic stated communication in general, but also just getting to the physical location of the wounded was problematic. Once on site, he said treating of the injured usually was not a problem.
- Another medic also stated knowing where the patient was physically located was a problem and suggested that if a homing like device on the patient could be activated so that he could find the patient that would be helpful.
- The issue of language problems existed for two medics who primarily treated local Iraqi civilians and other foreign nationals. One of these medics suggested a device that could translate various languages into English and vice-versa so that he and the patient could understand one another.

Other times diagnosis of the problem was because medics didn't have the proper equipment. Examples of these included:

- Five medics cited pulse oximetry as a tool they would like to have to assist in medical decision making.
- Information on allergies to medications. Although the medic who mentioned this problem didn't mentioned the BMIS-T because he was unaware of its capabilities; if he did have a tool like the BMIS-T it would have probably met his needs.
- Two other medics mentioned equipment to diagnose heat injuries and also a way to measure hydration rate.

Other things (each mentioned by one medic) that medics stated could have made a difference included:

- Having more tourniquets as often a rocket propelled grenade (RPG) attack will blow away multiple limbs on multiple people.
- Better medical equipment in general.
- Have X-Ray equipment closer to the front lines of combat.
- Having more medics in general.
- Having a way of accurately assessing blood loss.
- Having Dermabond (a liquid skin adhesive) to help close wounds.